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PAR-3

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A COMPUTER PROGRAM For Calculating Present Net Worth, Annual Equivalent Income and Rate-of-Return Simultaneously.

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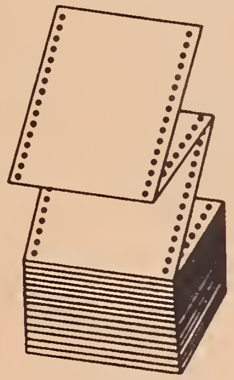
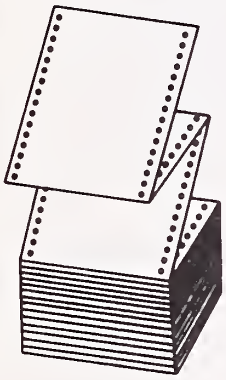


PAR-3

U. S. Department of Agriculture – Forest Service – Southeastern Area – State & Private Forestry

PAR-3

A COMPUTER PROGRAM
For Calculating Present Net Worth, Annual Equivalent Income and Rate-of-Return Simultaneously.



By William E. Balmer
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U. S. Department of Agriculture – Forest Service – Southeastern Area – State & Private Forestry

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OVERVIEW

This program is a modification of the Investment Analysis Program developed by CLark Row as described in SO-6, Determining Forest Investment Rates-of-Return by Electronic Computer, 1962 (Southern Forest Experiment Station, New Orleans, La.).

PAR-3 develops present net worth for six interest rates simultaneously for six alternatives. The program also calculates the internal rate of return for each alternative. In addition, PAR-3 calculates annual equivalent income for each of the six rates of interest for each alternative. This portion of the program is valid only for the final value option.

The variables are:

1. Yields for up to three different products.
2. Year of periodic costs and product returns.
3. Quality index for products.
4. Annual costs.
5. Annual increase in annual costs (simple interest).
6. Product prices.
7. Annual change in product prices (simple interest).
8. Final values.

Yield data is not generated within the program.

METHODS OF EXPRESSING RETURNS ON INVESTMENTS

A program that expresses return on investment in two or more ways is a more valuable tool than a program which gives only one measure of profitability. As mentioned above, the PAR-3 program measures return on investment in three ways. To help readers of this publication to visualize the differences between the three expressions of return on investment, a brief desciption of each follows:

Present Net Worth (PNW) is the difference between the present value of all cost (present and future) and income at a given interest. A positive PNW indicates that the investment furnishes a higher return than the selected interest rate. A PNW of zero indicates an investment that is just equaling the selected rate. The selected interest rate indicates the investors minimum objective or alternative investment opportunity.

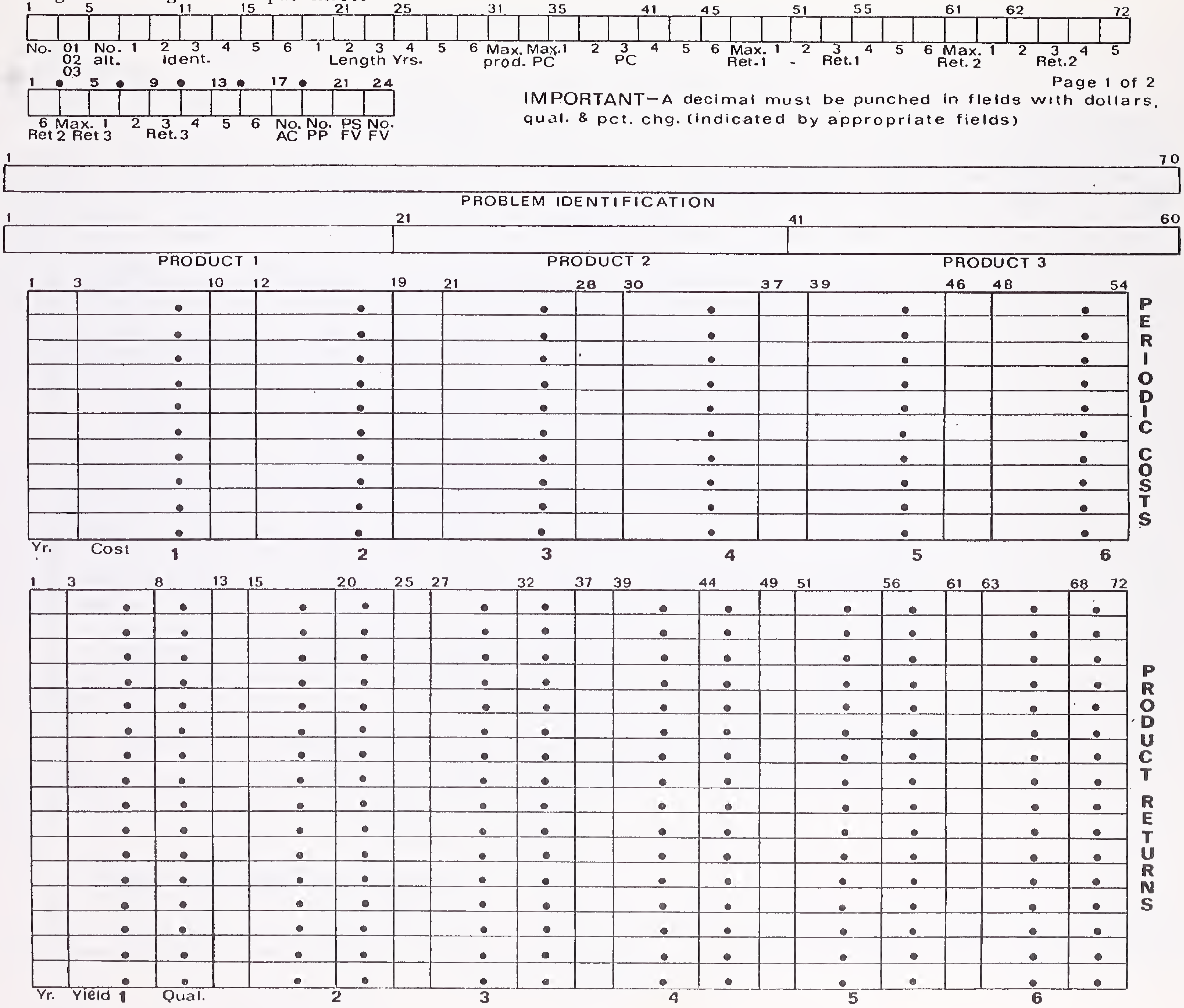
Annual Equivalent Value is the amount of annual income or payment that will just equal the present net worth of an investment during its lifetime. In forestry, these values are theoretical because income does not occur on an annual basis. However, these figures are useful in comparing forestry with investments that have annual returns.

Rate of Return (Sometime referred to as Internal Rate of Return) is the compound interest rate used where the present net worth is zero. In other words, rate of return is the compound interest rate that equates the present value of all future incomes with the present value of all future costs. It is assumed that all incomes can be reinvested at the same rate of return.

DATA PREPARATION

Appropriate data for each problem must be prepared and keypunched onto a computer card. Suitable forms for data entry are shown separately with appropriate data item and column identity. (See figures 1 and 2). Instructions for input entries follows:

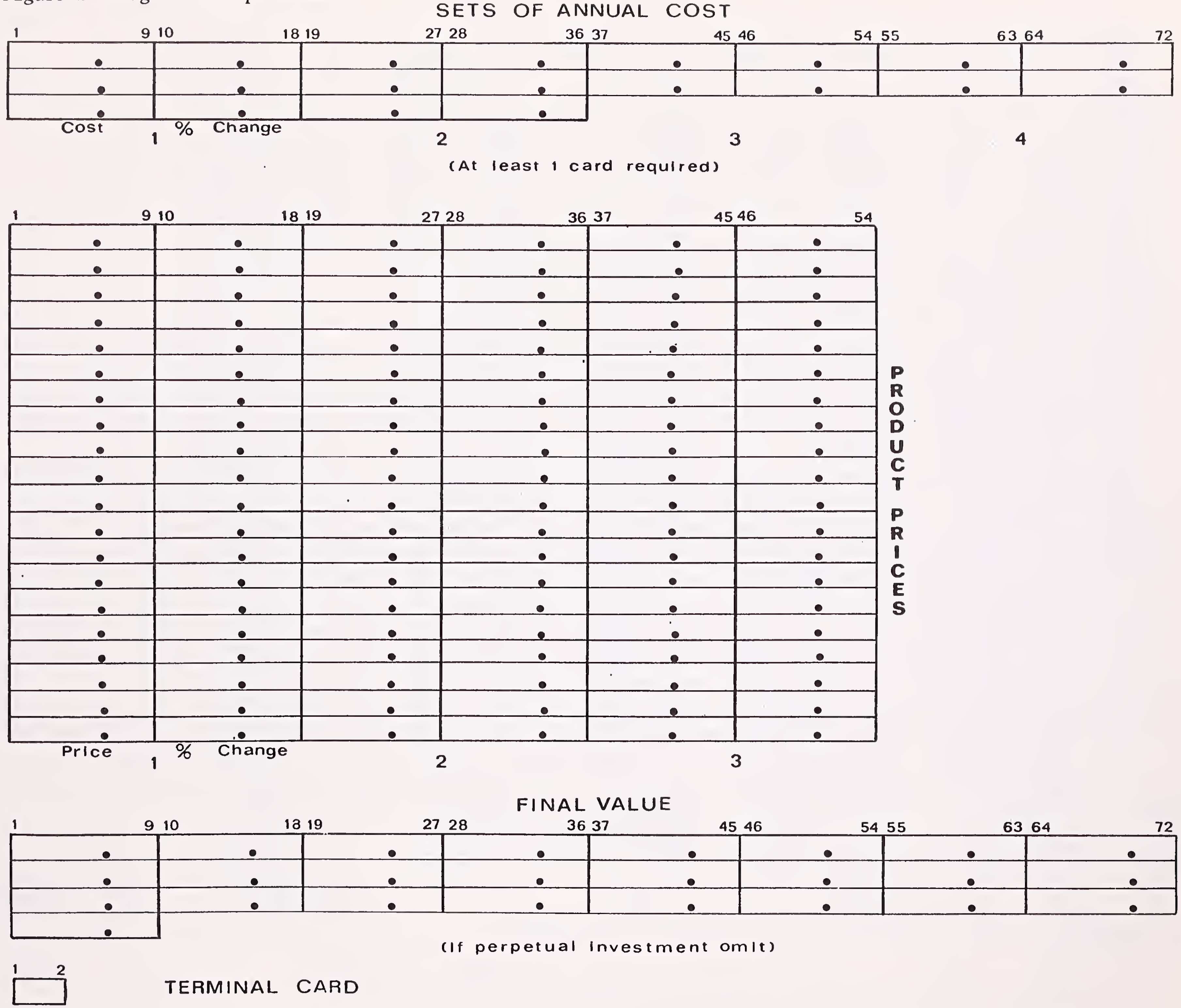
Figure 1 - Page 1 of Input Sheets



Page 1 of 2

IMPORTANT—A decimal must be punched in fields with dollars, qual. & pct. chg. (indicated by appropriate fields)

Figure 2 - Page 2 of Input Sheets



Card No. 1.-- Control card with 36 fields, 2 columns wide

Field 1, 2 No. - Problem No. - 01 to 99
3, 4 Type of Alternative (01 - Rotation
(02 - Site Index
(03 - Production system
5, 6 No. Alternatives - 01 to 06
7-18 Identification of each alternative (any appropriate 2-digit numbers)
19-30 Length in years of each alternative (01 to 99)
31-32 Maximum number of different products cut in any alternative (01 to 03)
33-34 Maximum number of periodic costs in any alternative (01 to 40)
35-46 Number of periodic costs in each alternative (01 to 40)
47-48 Maximum number of returns from product 1 in any alternative (01 to 50)
49-60 Number of returns of product 1 in each alternative (01 to 50)
61-62 Maximum number of returns from product 2 in any alternative (01 to 50)
63-72 Number of returns of product 2 in each alternative, 1 thru 5 (01 to 50)

Card No. 2.-- Control card with 12 fields, 2 columns wide

1-2 Number of returns of product 2 in alternative 6 (01 to 50)
3-4 Maximum number of returns from product 3, in any alternative (01 to 50)
5-16 Number of returns for each alternative (00 to 50)
17-18 Number of sets of annual costs (00 to 10)
19-20 Number of sets of product prices (00 to 20)
21-22 Type of terminal calculation: 01 if perpetual series, 02 if final value
23-24 Number of final values (00 to 25)

Card No. 3.-- Problem identification card

1-72 One field 72 columns wide - alphabetic or numeric

Card No. 4.-- Names of products card with 3 fields, each 20 columns wide

01-20 Name of product No. 1 - alphabetic or numeric
21-40 Name of product No. 2 - alphabetic or numeric
41-60 Name of product No. 3 - alphabetic or numeric

Card Group 5-- Periodic costs

The number of cards must equal maximum number of periodic costs in any alternative. Cards have six sets of two fields, 2 and 7 columns wide. Each set represents one periodic costs for corresponding investment alternative. Punch year cost occurs in first field, dollar amount in second. If problem has no cost, omit cards. Maximum of 40 periodic costs.

Card Group 6 -- Product returns

Returns from product 1 must be punched into as many cards as the maximum number of returns from product 1 in any alternative. These are followed by similar sets containing returns from product 2 and 3. Each card has six sets of three fields, 2, 5, and 5 column wide, corresponding to each alternative. Punch the year that the return occurs in the first field, quantity of yield in the second, and the quantity index in the third. Include cards only for the number of products cut.

Card Group 7. -- Annual costs

Punch each set (base annual cost, and change in annual cost) into pairs of fields from left to right across the card. The card may contain eight fields of nine columns. The change in the annual cost is punched as a decimal, not as a percent (2 percent is 0.02). At least one card is necessary. The Maximum number is 10 sets of annual costs.

Card Group 8. -- Product prices

Punch only one price assumption set in each card. Each set has a pair of values (base price and change in price in decimals, not percent) for each product in the problem. Cards may contain six 9-column fields. At least one card is necessary. The maximum number is 20 price sets.

Card Group No. 9. -- Final values

Final values, if used, are punched consecutively across the card. The card may contain eight 9-column fields. If the problem assumes a perpetual investment series rather than the final values, omit the cards. The maximum numberic is 25 final values. If there is no value and you are not using a perpetual series, use 0.0 in the first field.

Last card. -- Terminal card

Punch 98 in columns 1 and 2 if another problem follows, or 99 if it is the final problem.

Examples

The examples in this publication are used to illustrate some of the possible uses of the program rather than to provide answers to specific problems. Whole numbers are right justified in those entries showing decimals. In those entries with whole numbers, decimal points need not be punched.

The two sample problems illustrated are for loblolly pine for a site index 70. Two rotations (30 and 45 years) and 3 establishment costs (30, 60 and 90) are calculated simultaneously for each of 9 product price combinations and 2 annual costs ($.60 and $1.00). In problem 2 only, $15/acre cost for release is used. All other variables are the same as in problem 1. All cost, yields and returns are on an acre basis.

Input Data

The input data is as follows:

Table 1. Input Data for Six Alternatives -- Sample Problems

	Alternatives					
Input Variables	1	2	3	4	5	6
Rotation Length (yrs)	30	30	30	45	45	45
Periodic Costs Yr. 0	$30	$60	$90	$30	$60	$90
3 1/	15	15	15	15	15	15
Yields -- age 20 cords	6	6	6	6	6	6
-- age 30 cords	7	7	7	7	7	7
-- age 30 mbf	5.3	5.3	5.3	1.1	1.1	1.1
-- age 45 mbf 2/				11.7	11.7	11.7

1/ In same problem 2 only.

2/ To illustrate the use of quality as a variable, all products with the exception of sawtimber at 30 years in the 45-year-rotation are 100 percent (1.). For sawtimber at 30 years in the three 45-year-rotation alternatives, a quality of 90 percent (.9) is assumed. The effect will be the use of 90 percent of the sawtimber value at that time in the calculations.

Two levels of annual costs are used:
$.60 per acre increased 2 percent annually--simple interest, and
$1.00 per acre increased 2 percent annually--simple interest.

Product Price Combinations

$/cd		$/MBF
5	and	50
5	"	75
8	"	100
8	"	50
8	"	75
8	"	100
11	"	50
11	"	75
11	"	100

All prices and annual costs increase 2 percent annually--simple interest. A final value of 0.0 is used.

Figures 3 and 4 are input sheets for problem 1. Items 1, 2 and 3 match the input sheet. Item 4 includes one set of variables that apply to all six alternatives. The first set is for annual costs of $.60, pulpwood selling prices of $5 per cord and $50 per MBF. Item 5 is the Present Net Worth at six different interest rates. Item 6 is the Internal Rate of Return expressed as compound interest for each of the alternatives. Item 7 is the Equivalent Annual Income for each of the alternatives, for each of the six interest rates. Item 8 is the same problem with the second set of product prices -- $5 per cord and $75 per thousand board feet.

Figure 6 is an input sheet identical to figure 3 with the exception of the addition of a periodic cost at year 3 of $15 for release. The second input sheet would be unchanged except for the terminal card which is 99.

Figure 7 is a partial printout of this new set of alternatives. The effects of the 15 additional years on the investment can be readily compared for each combination of establishment cost, product prices and annual cost.

Sample Output Summary

The following tables partially summarize the output for the two problems: Table 2 lists the IRR, Present Net Worth at 8 percent and Annual Equivalent Income at 8 percent for Problem 1 for the 9 product prices and a $.60 per acre annual cost. Table 3 lists the IRR, Persent Net Worth at 8 percent and Annual Equivalent Income at 8 percent for Problem 2. The only change from Problem 1 is the $15 release cost at age 3. Only the $.60 per acre annual cost is summarized.

Figure 3 - Input Sheet 1 for Problem 1

1		5			11		15			21		25				31	
01	01	06	30	30	30	45	45	45	30	30	30	45	45	45	02	01	01
No. 09	01 02 03	No. alt.	1	2 Ident.	3	4	5	6	1	2 Length Yrs.	3	4	5	6	Max. prod.	Max. PC	1

35		41		45			51		55			61		62			72
01	01	01	01	01	02	02	02	02	02	02	02	02	01	01	01	02	02
2	3 PC	4	5	6	Max. Ret.1	1	2 -	3 Ret.1	4	5	6	Max. Ret. 2	1	2	3 Ret.2	4	5

1		5		9		13		17		21	24
02								02	09	02	01
6 Ret 2	Max. Ret 3	1	2	3 Ret. 3	4	5	6	No. AC	No. PP	PS FV	No. FV

Page 1 of 2

IMPORTANT—A decimal must be punched in fields with dollars, qual. & pct. chg. (indicated by appropriate fields)

1	70
LOBLOLLY PINE SITE INDEX 70 30 AND 45 YEAR ROTATIONS	

PROBLEM IDENTIFICATION

1	21	41 60
PULPWOOD - CORDS	SAWTIMBER - MBF	
PRODUCT 1	PRODUCT 2	PRODUCT 3

PERIODIC COSTS

1	3	10	12	19	21	28	30	37	39	46	48 54
00	30.	00	60.	00	90.	00	30.	00	60.	00	90.
	.		.		.		.		.		.
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	.		.		.		.		.		.
Yr.	Cost 1		2		3		4		5		6

PRODUCT RETURNS

1	3	8	13	15	20	25	27	32	37	39	44	49	51	56	61	63	68 72
20	6.	1.	20	6.	1.	20	6.	1.	20	6.	1.	20	6.	1.	20	6.	1.
30	7.	1.	30	7.	1.	30	7.	1.	30	7.	1.	30	7.	1.	30	7.	1.
30	5.3	1.	30	5.3	1.	30	5.3	1.	30	1.1	.9	30	1.1	.9	30	1.1	.9
	.	.		.	.		.	.	45	11.7	1.	45	11.7	1.	45	11.7	1.
	.	.		.	.		.	.		.	.		.	.		.	.
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Yr.	Yield 1	Qual.		2			3			4			5			6	

Figure 4 - Input Sheet 2 for Problem 1

SETS OF ANNUAL COST

1 9	10 18	19 27	28 36	37 45	46 54	55 63	64 72
.60	.02	1.00	.02	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.				

Cost % Change

1 2 3 4

(At least 1 card required)

PRODUCT PRICES.

1 9	10 18	19 27	28 36	37 45	46 54
5.	.02	50.	.02	.	.
5.	.02	75.	.02	.	.
5.	.02	100.	.02	.	.
8.	.02	50.	.02	.	.
8.	.02	75.	.02	.	.
8.	.02	100.	.02	.	.
11.	.02	50.	.02	.	.
11.	.02	75.	.02	.	.
11.	.02	100.	.02	.	.
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Price % Change

1 2 3

FINAL VALUE

1 9	10 18	19 27	28 36	37 45	46 54	55 63	64 72
0.0	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.							

(If perpetual investment omit)

1 2
98

TERMINAL CARD

Figure 5 — Partial printout of Problem 1.

```
                                  ROW'S INVESTMENT ANALYSIS PROGRAM     SOUTHERN FOREST EXPERIMENT STATION
                                      - PAR-3 REVISION BY STEBER, BALMER, AND UTZ -
                                             STATE & PRIVATE FORESTRY, SE AREA

        PROBLEM NO    1 LOBLOLLY PINE SITE INDEX 70 30 AND 45 YEAR ROTATIONS

                                                 ROTATION LENGTH IN YEARS
               30               30               30               45               45               45

        PERIODIC COSTS
Item 1  YEAR    COST     YEAR    COST     YEAR    COST     YEAR    COST     YEAR    COST     YEAR    COST
         0     30.00      0     60.00      0     90.00      0     30.00      0     60.00      0     90.00

        PERIODIC RETURNS FROM PULPWOOD - CORDS
        YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL
Item 2   20   6.0  1.00    20   6.0  1.00    20   6.0  1.00    20   6.0  1.00    20   6.0  1.00    20   6.0  1.00
         30   7.0  1.00    30   7.0  1.00    30   7.0  1.00    30   7.0  1.00    30   7.0  1.00    30   7.0  1.00

        PERIODIC RETURNS FROM SAWTIMBER - MBF
Item 3  YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL   YEAR YIELD QUAL
         30   5.3  1.00    30   5.3  1.00    30   5.3  1.00    30   1.1   .90    30   1.1   .90    30   1.1   .90
          0    .0   .00     0    .0   .00     0    .0   .00    45  11.7  1.00    45  11.7  1.00    45  11.7  1.00

        ANNUAL COST                   $     .60      CHANGE IN ANNUAL COST                     2.00 PERCENT PER YEAR
        PRICE OF PULPWOOD - CORDS     $    5.00      CHANGE IN PRICE OF PULPWOOD - CORDS       2.00 PERCENT PER YEAR
Item 4  PRICE OF SAWTIMBER - MBF      $   50.00      CHANGE IN PRICE OF SAWTIMBER - MBF        2.00 PERCENT PER YEAR
        VALUE AT END OF ONE INVESTMENT $    .00
        PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST
        RATE      30      30      30      45      45      45      RATE      30      30      30      45      45      45
         6.0    56.70   26.70   -3.30   75.68   45.68   15.68     12.0    -15.16  -45.16  -75.16  -20.13  -50.13  -80.13
Item 5   8.0    18.72  -11.28  -41.28   18.40  -11.60  -41.60     14.0    -22.27  -52.27  -82.27  -26.11  -56.11  -86.11
        10.0    -2.83  -32.83  -62.83   -7.79  -37.79  -67.79     16.0    -26.39  -56.39  -86.39  -29.08  -59.08  -89.08
Item    IRR=     9.66    7.28    5.87    9.23    7.45    6.41
       EQUIVALENT ANNUAL INCOME AT GIVEN ALTERNATIVE RATES OF INTEREST
        RATE      30      30      30      45      45      45      RATE      30      30      30      45      45      45
         6.0     3.67    1.73    -.21    4.90    2.96    1.01     12.0     -1.83   -5.45   -9.07   -2.43   -6.05   -9.67
Item 7   8.0     1.55    -.93   -3.41    1.52    -.96   -3.44     14.0     -3.13   -7.34  -11.55   -3.67   -7.88  -12.09
        10.0     -.29   -3.33   -6.37    -.79   -3.83   -6.87     16.0     -4.23   -9.03  -13.84   -4.66   -9.46  -14.27

        ANNUAL COST                   $     .60      CHANGE IN ANNUAL COST                     2.00 PERCENT PER YEAR
        PRICE OF PULPWOOD - CORDS     $    5.00      CHANGE IN PRICE OF PULPWOOD - CORDS       2.00 PERCENT PER YEAR
Item 8  PRICE OF SAWTIMBER - MBF      $   75.00      CHANGE IN PRICE OF SAWTIMBER - MBF        2.00 PERCENT PER YEAR
        VALUE AT END OF ONE INVESTMENT $    .00
        PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST
        RATE      30      30      30      45      45      45      RATE      30      30      30      45      45      45
         6.0    93.61   63.61   33.61  122.95   92.95   62.95     12.0     -8.09  -38.09  -68.09  -15.41  -45.41  -75.41
         8.0    39.78    9.78  -20.22   39.74    9.74  -20.26     14.0    -18.11  -48.11  -78.11  -23.80  -53.80  -83.80
        10.0     9.32  -20.68  -50.68    2.11  -27.89  -57.89     16.0    -23.92  -53.92  -83.92  -27.92  -57.92  -87.92
        IRR=    10.93    8.53    7.11   10.17    8.39    7.35
```

Figure 6 - Input Sheet for Problem 2

1		5			11		15			21		25			31		35			41		45			51		55			61	62				72
02	01	06	30	30	30	45	45	45	30	30	30	45	45	45	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	01	01	01	02	02
No.	01 02 03	No. alt.	1	2 Ident.	3	4	5	6	1	2 Length Yrs.	3	4	5	6	Max. prod. PC	Max. 1	2	3 PC	4	5	6	Max. Ret.1	1	2	3 Ret.1	4	5	6	Max. Ret. 2	1	2	3 Ret.2	4	5	

1		5		9		13		17		21	24
02								02	09	02	01
6 Ret 2	Max. Ret 3	1	2	3 Ret.3	4	5	6	No. AC	No. PP	PS FV	No. FV

Page 1 of 2

IMPORTANT—A decimal must be punched in fields with dollars, qual. & pct. chg. (indicated by appropriate fields)

1 | LOBLOLLY PINE SITE INDEX 70 30 AND 45 YEAR ROTATION - RELEASE AGE 3 | 70

PROBLEM IDENTIFICATION

1	21	41	60
PULP WOOD - CORDS	SAWTIMBER - MBF		
PRODUCT 1	PRODUCT 2	PRODUCT 3	

PERIODIC COSTS

1	3	10	12	19	21	28	30	37	39	46	48 54
00	30.	00	60.	00	90.	00	30.	00	60.	00	90.
03	15.	03	15.	03	15.	03	15.	03	15.	03	15.
	.		.		.		.		.		.
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Yr.	Cost 1		2		3		4		5		6

PRODUCT RETURNS

1	3	8	13	15	20	25	27	32	37	39	44	49	51	56	61	63	68 72
20	6.	1.	20	6.	1.	20	6.	1.	20	6.	1.	20	6.	1.	20	6.	1.
30	7.	1.	30	7.	1.	30	7.	1.	30	7.	1.	30	7.	1.	30	7.	1.
30	5.3	1.	30	5.3	1.	30	5.3	1.	30	1.1	.9	30	1.1	.9	30	1.1	.9
	.	.		.	.		.	.	45	11.7	1.	45	11.7	1.	45	11.7	1.
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Yr.	Yield 1	Qual.		2			3			4			5			6	

Figure 7 — Partial printout of Problem 2.

```
                          ROW'S INVESTMENT ANALYSIS PROGRAM     SOUTHERN FOREST EXPERIMENT STATION
                                   - PAR-3 REVISION BY STEBER, BALMER, AND UTZ -
                                         STATE & PRIVATE FORESTRY, SE AREA

PROBLEM NO    2 LOBLOLLY PINE SITE INDEX 70 30 AND 45 YEAR ROTATION - RELEASE AGE 3

                                                ROTATION LENGTH IN YEARS
     30                  30                  30                  45                  45                  45

PERIODIC COSTS
YEAR    COST        YEAR    COST        YEAR    COST        YEAR    COST        YEAR    COST        YEAR    COST
 0     30.00          0     60.00         0     90.00         0     30.00         0     60.00         0     90.00
 3     15.00          3     15.00         3     15.00         3     15.00         3     15.00         3     15.00

PERIODIC RETURNS FROM PULPWOOD - CORDS
YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL
 20    6.0  1.00     20    6.0  1.00     20    6.0  1.00     20    6.0  1.00     20    6.0  1.00     20    6.0  1.00
 30    7.0  1.00     30    7.0  1.00     30    7.0  1.00     30    7.0  1.00     30    7.0  1.00     30    7.0  1.00

PERIODIC RETURNS FROM SAWTIMBER - MBF
YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL     YEAR YIELD QUAL
 30    5.3  1.00     30    5.3  1.00     30    5.3  1.00     30    1.1   .90     30    1.1   .90     30    1.1   .90
  0     .0   .00      0     .0   .00      0     .0   .00     45   11.7  1.00     45   11.7  1.00     45   11.7  1.00

ANNUAL COST                       $    .60       CHANGE IN ANNUAL COST                         2.00 PERCENT PER YEAR
PRICE OF PULPWOOD - CORDS         $   5.00       CHANGE IN PRICE OF PULPWOOD - CORDS           2.00 PERCENT PER YEAR
PRICE OF SAWTIMBER - MBF          $  50.00       CHANGE IN PRICE OF SAWTIMBER - MBF            2.00 PERCENT PER YEAR
VALUE AT END OF ONE INVESTMENT    $    .00
PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST
RATE        30      30      30      45      45      45     RATE      30      30      30      45      45      45
 6.0     44.11   14.11  -15.89   63.08   33.08    3.08     12.0  -25.84  -55.84  -85.84  -30.80  -60.80  -90.80
 8.0      6.81  -23.19  -53.19    6.49  -23.51  -53.51     14.0  -32.40  -62.40  -92.40  -36.23  -66.23  -96.23
10.0    -14.10  -44.10  -74.10  -19.06  -49.06  -79.06     16.0  -36.00  -66.00  -96.00  -38.69  -68.69  -98.69
IRR=      8.53    6.63    5.41    8.38    6.97    6.08
EQUIVALENT ANNUAL INCOME AT GIVEN ALTERNATIVE RATES OF INTEREST
RATE        30      30      30      45      45      45     RATE      30      30      30      45      45      45
 6.0      2.85     .91   -1.03    4.08    2.14     .20     12.0   -3.12   -6.74  -10.36   -3.72   -7.34  -10.96
 8.0       .56   -1.92   -4.39     .54   -1.94   -4.42     14.0   -4.55   -8.76  -12.97   -5.09   -9.30  -13.51
10.0     -1.43   -4.47   -7.51   -1.93   -4.97   -8.02     16.0   -5.77  -10.57  -15.38   -6.20  -11.00  -15.81

ANNUAL COST                       $    .60       CHANGE IN ANNUAL COST                         2.00 PERCENT PER YEAR
PRICE OF PULPWOOD - CORDS         $   5.00       CHANGE IN PRICE OF PULPWOOD - CORDS           2.00 PERCENT PER YEAR
PRICE OF SAWTIMBER - MBF          $  75.00       CHANGE IN PRICE OF SAWTIMBER - MBF            2.00 PERCENT PER YEAR
VALUE AT END OF ONE INVESTMENT    $    .00
PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RATES OF INTEREST
RATE        30      30      30      45      45      45     RATE      30      30      30      45      45      45
 6.0     81.02   51.02   21.02  110.35   80.35   50.35     12.0  -18.76  -48.76  -78.76  -26.09  -56.09  -86.09
 8.0     27.88   -2.12  -32.12   27.84   -2.16  -32.16     14.0  -28.24  -58.24  -88.24  -33.93  -63.93  -93.93
10.0     -1.95  -31.95  -61.95   -9.16  -39.16  -69.16     16.0  -33.53  -63.53  -93.53  -37.53  -67.53  -97.53
IRR=      9.83    7.89    6.66    9.34    7.92    7.02
```

Table 2. -- Sample output summary: Problem 2, loblolly pine with release at age 3; site Index is 70; 30 and 45-Year rotation.

		IRR					
		Establishment cost					
Product	Price	$30	60	90	30	60	90
Pulp (Cords)	ST (MBF)	30 yr	30 yr	30 yr	45 yr	45 yr	45 yr
		Percent					
5	50	9.7	7.3	5.9	9.2	7.5	6.4
5	75	10.9	8.5	7.1	10.2	8.4	7.3
5	100	11.9	9.5	8.0	10.9	9.1	8.0
8	50	10.3	7.9	6.4	9.8	7.9	6.8
8	75	11.5	9.0	7.5	10.6	8.7	7.6
8	100	12.3	9.8	8.4	11.3	9.4	8.3
11	50	10.9	8.4	6.9	10.3	8.3	7.1
11	75	11.9	9.4	7.9	11.1	9.1	7.9
11	100	12.7	10.2	8.7	11.7	9.7	8.5
		Present net worth at 8 percent					
		dollar					
5	50	18	-11	-41	18	-12	-42
5	75	40	10	-20	40	10	-20
5	100	61	31	1	61	31	1
8	50	27	-3	-33	27	-3	-33
8	75	49	19	-11	49	18	-12
8	100	70	40	10	70	40	10
11	50	36	6	-24	36	6	-24
11	75	57	27	-3	57	27	-3
11	100	78	48	18	79	49	19
		Annual equivalent income at 8 percent					
		dollar					
5	50	1.55	-.93	-3.41	1.52	-.96	-3.44
5	75	3.29	.81	-1.67	3.28	.89	-1.67
5	100	5.03	2.55	.07	5.05	2.57	.09
8	50	2.37	-.21	-2.69	2.24	-.24	-2.71
8	75	4.01	1.53	-.95	4.00	1.53	-.95
8	100	5.75	3.27	.79	5.77	3.29	.81
11	50	2.99	.51	-1.96	2.96	.49	-1.99
11	75	4.73	2.25	-.23	4.73	2.25	-.23
11	100	6.47	3.99	1.51	6.49	4.01	1.53

Table 3.--- Sample output summary: Problem 2, loblolly pine with release at age 3; site Index is 70; 30 and 45 year rotation.

Product	Price	IRR					
		Establishment cost					
Pulp	ST	30	60	90	30	60	90
(Cords)	(MBF)	30 yr	30 yr	30 yr	45 yr	45 yr	45 yr
		percent					
5	50	8.5	6.6	5.4	8.4	7.0	6.1
5	75	9.8	7.9	6.7	9.3	7.9	7.0
5	100	10.8	8.8	7.6	10.1	8.6	7.7
8	50	9.2	7.2	5.9	8.9	7.4	6.4
8	75	10.3	8.3	7.1	9.7	8.2	7.3
8	100	11.2	9.2	7.9	10.4	8.9	7.9
11	50	9.7	7.7	6.4	9.4	7.7	6.7
11	75	10.8	8.7	7.4	10.1	8.5	7.6
11	100	11.6	9.5	8.2	10.8	9.2	8.2
		Present net worth at 8 percent					
		dollar					
5	50	7	-23	-53	6	-24	-54
5	75	28	-2	-32	28	-2	-32
5	100	49	19	-11	49	19	-11
8	50	16	-14	-44	15	-15	-45
8	75	37	7	-23	37	7	-23
8	100	58	28	-2	58	28	-2
11	50	24	-6	-36	24	-6	-36
11	75	45	15	-15	45	15	-15
11	100	66	36	6	67	37	7
		Annual equivalent income at 8 percent					
		dollar					
5	50	.56	-1.92	-4.39	.54	-1.94	-4.42
5	75	2.30	-.18	-2.65	2.30	-.18	-2.66
5	100	4.04	1.56	-.91	4.06	1.58	-.89
8	50	1.28	-1.19	-3.67	1.26	-1.22	-3.70
8	75	3.02	.55	-1.93	3.02	.54	-1.93
8	100	4.76	2.29	.19	4.78	2.31	-.17
11	50	2.01	-.47	-2.95	1.98	-.50	-2.97
11	75	3.75	1.27	-1.21	3.74	1.27	-1.21
11	100	5.47	3.01	.53	5.51	3.03	.55

PROGRAM SPECIFICATIONS

The computer program is written in FORTAN IV and should operate on computers having this capability with little or no modification. The program is listed as an appendix, pages 17-22. Processing through the program is generally straight-forward with little branching. The six rates of interest used for present net worth and equivalent annual income can be changed easily by a programmer. The program decks and data entry forms are available from the Southeastern Area.

PROGRAM OPERATION

The program is written to accept data punched on computer cards, although modification for data entry from a terminal would not be difficult. The job setup for operation of the program will consist of the appropriate job control cards to compile the computer program or to retrieve the compiled program from the program library plus a data deck of problem cards. The data for each problem is punched on several computer cards and as many problems may be processed in a single run as desired by use of 98 cards between problems. Processing is terminated by encountering an end-of-file card (99) following the data. Processing costs should be modest.

APPENDIX A

Listing of Computer Program

```
@FOR,I       PAR 3
      DATA MPR/6/,MRE/5/
C     INVESTMENT ANALYSIS PROGRAM SOUTHERN FOREST EXPERIMENT STATION
C    1CLARK ROW 62    1005 DLT 1108 FEB. 12 70
      DIMENSION ANC(10), CANC(10), NC(6,40), PECO(6,40), N1(6,50),
     1YLD1(6,50), QUAL1(6,50), N2(6,50), QUAL2(6,50), N3(6,50), YLD3
     2(6,50), QUAL3(6,50), PR(3,30),CPR(3,30), FVAL(25), RATE(27),
     3RTLOG(27), VALIN(6,27), LY(6), KCX(6), K1X(6), K2X(6), K3X(6),
     4A(33), LI(6),YLD2(6,50),ROR(6), EAI (6,6)
      RATE(1)=.060
      RATE(7)=.001
      RATE(8)=1.0
      DO 136 I=1,6
  130 IF (RATE(I)-.158)135,137,137
  135 RATE(I+1)=RATE(I)+.020
  136 CONTINUE
  137 DO 138 I=1,8
  138 RTLOG(I)=ALOG(1.0+RATE(I))
  142 READ (5,11)NO,LZ,LX,(LI(L),L=1,6),(LY(L),L=1,6),KX,KCXX,(KCX(L),L=
     11,6),K1XX,(K1X(L),L=1,6),K2XX,(K2X(L),L= 1,6),K3XX,(K3X(L),L=1,6),
     2 JX,MX,NZ,NX
   11 FORMAT(36I2)
      READ (MRE,15)(A(I),I=1,18)
   15 FORMAT (18A4)
      READ (MRE,15) (A(I),I=19,33)
      WRITE (MPR,20)
   20 FORMAT(1H1,28X,72HROW'S INVESTMENT ANALYSIS PROGRAM      SOUTHERN F
     *OREST EXPERIMENT STATION/   42X,'- PAR-3 REVISION BY STEBER, BALME
     1R, AND UTZ - ',/ 48X,'STATE & PRIVATE FORESTRY, SE AREA')
      WRITE (MPR,21) NO,(A(I),I=1,18)
   21 FORMAT (14H0  PROBLEM NO , I4, 1H , 18A4)
  144 IF(LZ-2)145,146,147
  145 WRITE (MPR,23)
   23 FORMAT (73H0                                                  ROTATI
     1ON LENGTH IN YEARS)
      GO TO 149
  146 WRITE (MPR,24)
   24 FORMAT (70H0                                                     SIT
     1E INDEX IN FEET)
      GO TO 149
  147 WRITE (MPR,25)
   25 FORMAT (69H0                                                     PRO
     1DUCTION SYSTEM)
  149 WRITE (MPR,26) (LI(L),L=1,LX)
   26 FORMAT (I11,5I20)
      IF (KCXX) 160,160,152
  152 WRITE (MPR,27)
   27 FORMAT (17H0  PERIODIC COSTS,/115H   YEAR     COST        YEAR    C
     1OST        YEAR     COST         YEAR    COST         YEAR    COST
     2      YEAR    COST)
      DO 155 KC=1,KCXX
      READ (MRE,13) (NC(L,KC),PECO(L,KC),L=1,6)
   13 FORMAT(6(I2,F7.2))
  155 WRITE (MPR,29)(NC(L,KC), PECO(L,KC),L=1,LX)
   29 FORMAT (I6,F9.2,5(I11,F9.2))
  160 IF (K1XX) 170,170,162
  162 WRITE (MPR,30) (A(I),I=19,23)
   30 FORMAT (25H0  PERIODIC RETURNS FROM , 5A4)
      WRITE (MPR,31)
   31 FORMAT (118H   YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD
     1QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL      YEAR YIELD QUAL)
      DO 165 K1= 1,K1XX
      READ (MRE,14) (N1(L,K1),YLD1(L,K1),QUAL1(L,K1),L=1,6)
   14 FORMAT (6(I2,F5.1,F5.2))
  165 WRITE (MPR,32)(N1(L,K1),YLD1(L,K1),QUAL1(L,K1), L=1,LX)
   32 FORMAT (I6, F6.1, F6.2, 5(I8, F6.1, F6.2))
  170 IF(K2XX) 180,180,172
  172 WRITE (MPR,30) (A(I),I=24,28)
      WRITE (MPR,31)
      DO 175 K2=1,K2XX
      READ (5,14)(N2(L,K2),YLD2(L,K2),QUAL2(L,K2),L=1,6)
  175 WRITE (MPR,32)(N2(L,K2),YLD2(L,K2),QUAL2(L,K2),L=1,LX)
  180 IF (K3XX) 190,190,182
  182 WRITE (MPR,30)(A(I), I=29,33)
      WRITE (MPR,31)
      DO 185 K3=1,K3XX
      READ (5,14)(N3(L,K3),YLD3(L,K3),QUAL3(L,K3),L=1,6)
  185 WRITE (MPR,32)(N3(L,K3),YLD3(L,K3),QUAL3(L,K3),L=1,LX)
   12 FORMAT(8F9,3)
  190 READ (5,12)(ANC(J), CANC(J),J=1,JX)
      DO 191 M=1,MX
  191 READ (5,12)(PR(K,M), CPR(K,M), K=1,KX)
  192 IF(NZ-1)195,195,193
  193 READ (5,12)(FVAL(N),N=1,NX)
  195 DO 390 J=1,JX
      DO 390 M=1,MX
  198 DO 390 N=1,NX
      WRITE (MPR,34)ANC(J),CANC(J)
   34 FORMAT (37H0  ANNUAL COST                             $, F7.2,  46H
     1 CHANGE IN ANNUAL COST                          ,2PF11.2, 17H PERCENT PER
     2YEAR)
      WRITE (MPR,35)(A(5*K+14),A(5*K+15),A(5*K+16),A(5*K+17),A(5*K+18),
     1PR(K,M),A(5*K+14),A(5*K+15),A(5*K+16),A(5*K+17),A(5*K+18),CPR(K,M
     2),K=1,KX)
   35 FORMAT (12H   PRICE OF , 5A4, 5H    $,0PF7,2, 26H        CHANGE IN
     1PRICE OF , 5A4,2PF11.2, 17H PERCENT PER YEAR)
      IF(NZ-1)204,204,205
  204 WRITE (MPR,36)
   36 FORMAT (30H   PERPETUAL INVESTMENT SERIES)
      GO TO 210
  205 WRITE (MPR,37) FVAL(N)
   37 FORMAT (37H   VALUE AT END OF ONE INVESTMENT   $, F7,2)
  210 DO 345 L=1,LX
      KCXA=KCX(L)
      K1XA=K1X(L)
      K2XA=K2X(L)
      K3XA=K3X(L)
      XLY=FLOAT(LY(L))
      DO 340 I=1,8
      CALL CALC(KCXA,K1XA,K2XA,K3XA,XLY,RTLOG,ANC,J,I,RATE,
     1CANC,NC,L,PECO,N1,YLD1,PR,M,QUAL1,CPR,N2,YLD2,QUAL2,N3,YLD3,
     2QUAL3,NZ,FVAL,N,VALIN)
  340 CONTINUE
      JJ=0
      IF(VALIN(L,7)*VALIN(L,8))501,502,500
500      ROR(L)=0.0
      GOTO 345
502   ROR(L)=RATE(7)
      IF(VALIN(L,8).EQ.0.0)ROR(L)=RATE(8)
      GOTO 345
501   R1=RATE(7)
      R3=RATE(8)
      V1=VALIN(L,7)
      V3=VALIN(L,8)
504   RATE(27)=(R1+R3)/2.0
      RTLOG(27)=LOG(1.0+RATE(27))
      ROR(L)=RATE(27)
      I=27
      CALL CALC(KCXA,K1XA,K2XA,K3XA,XLY,RTLOG,ANC,J,I,RATE,
     1CANC,NC,L,PECO,N1,YLD1,PR,M,QUAL1,CPR,N2,YLD2,QUAL2,N3,YLD3,
     2QUAL3,NZ,FVAL,N,VALIN)
503   JJ=JJ+1
      IF(JJ.EQ.17) GO TO 345
         IF(ABS(VALIN(L,27)).LT.5E-3)GOTO 345
      IF(V1*VALIN(L,27))505,509,506
505   V3=VALIN(L,27)
      R3=RATE(27)
      GOTO 504
506   V1=VALIN(L,27)
      R1=RATE(27)
      GOTO 504
509   WRITE(MPR,599)
599   FORMAT(' ERROR IN CHANGES')
      STOP
  345 CONTINUE
      WRITE (MPR,38)
   38 FORMAT (70H   PRESENT DISCOUNTED NET WORTH AT GIVEN ALTERNATIVE RA
     1TES OF INTEREST)
      WRITE (MPR,40)(LY(L),L=1,6),(LY(L),L=1,6)
   40 FORMAT (7H   RATE, I9, 5I8, 12H         RATE, I9, 5I8)
      DO 365 I=1,3
  365 WRITE (MPR,41)RATE(I),(VALIN(L,I), L=1,6),RATE(I+ 3),(VALIN(L,I+ 3
     1), L=1,6)
   41 FORMAT(2PF7.1,0PF11.2,0P5F8.2,2PF9.1,0PF11.2,0P5F8.2)
      WRITE(MPR,45) (ROR(I),I=1,6)
45    FORMAT('   IRR='2PF11.2,5F8.2)
      IF (NZ .EQ. 1) GO TO 390
      DO 600 I = 1,6
      DRATE = (1.0 + RATE(I)) ** LY(L)
      DO 600 L = 1,6
      EAI (L,I) = (RATE(I) * DRATE) / (DRATE - 1.0)
      EAI(L,I) = EAI(L,I) * VALIN(L,I)
  600 CONTINUE
      WRITE (MPR,601)
  601 FORMAT ('  EQUIVALENT ANNUAL INCOME AT GIVEN ALTERNATIVE RATES O'
     *    , 'F INTEREST')
      WRITE(MPR, 40) (LY(L), L=1,6),(LY(L),L=1,6),
      DO 602 I = 1,3
      WRITE (MPR,41) RATE(I), (EAI(L,I),L=1,6),RATE(I+3),
     *    (EAI(L,I+3),L=1,6)
  602 CONTINUE
  390 CONTINUE
      READ (MRE,11)IEND
      IF(IEND-98)400,142,410
  400 WRITE (MPR,42)
   42 FORMAT(23H0  ERROR IN INPUT CARDS)
  410 CONTINUE
      WRITE (MPR,2014)
 2014 FORMAT (1H1)
      STOP
      END
@FOR,I    .CALC
      SUBROUTINE CALC(KCXA,K1XA,K2XA,K3XA,XLY,RTLOG,ANC,J,I,RATE,
     1CANC,NC,L,PECO,N1,YLD1,PR,M,QUAL1,CPR,N2,YLD2,QUAL2,N3,YLD3,
     2QUAL3,NZ,FVAL,N,VALIN)
      DIMENSION ANC(10), CANC(10), NC(6,40), PECO(6,40), N1(6,50),
     1YLD1(6,50), QUAL1(6,50), N2(6,50), QUAL2(6,50), N3(6,50), YLD3
     2(6,50), QUAL3(6,50), PR(3,30),CPR(3,30), FVAL(25), RATE(27),
     3RTLOG(27), VALIN(6,27),
     4YLD2(6,50)
      DISC(Q000FL)=EXP(RTLOI*Q000FL)
      DANC=0.0
      DCANC=0.0
      DKC=0.0
      DK1=0.0
      DK2=0.0
      DK3=0.0
      DFVAL=0.0
      RTLOI=RTLOG(I)
      DISCO=EXP(RTLOG(I)*XLY)
      IF(ANC(J)) 225,230,225
  225 DANC=(ANC(J)*(DISCO-1.0))/(RATE(I)*DISCO)
  230 IF (CANC(J)) 235,240,235
  235 DCANC=(CANC(J)*ANC(J)*(DISCO-XLY*RATE(I)-1.0))/(RATE(I)**2*DISCO)
  240 IF(KCXA) 250,250,241
  241 DO 245 KC=1,KCXA
      XNC=FLOAT(NC(L,KC))
  245 DKC=DKC+PECO(L,KC)/DISC(XNC)
  250 IF (K1XA) 260,260,251
  251 DO 255 K1=1,K1XA
      XN1=FLOAT(N1(L,K1))
  255 DK1=DK1+(YLD1(L,K1)*PR(1,M)*QUAL1(L,K1)*(1.0+CPR(1,M) *XN1))/DISC(
     1XN1)
  260 IF (K2XA)270,270,261
  261 DO 265 K2=1,K2XA
      XN2=FLOAT(N2(L,K2))
  265 DK2=DK2+(YLD2(L,K2)*PR(2,M)*QUAL2(L,K2)*(1.0+CPR(2,M )*XN2))/DISC(
     1XN2)
  270 IF(K3XA)280,280,271
  271 DO 275 K3=1,K3XA
      XN3=FLOAT(N3(L,K3))
  275 DK3=DK3+(YLD3(L,K3)*PR(3,M)*QUAL3(L,K3)*(1.0+CPR(3,M)*XN3)) /DISC(
     1XN3)
  280 TDVAL=DK1+DK2+DK3-DANC-DCANC-DKC
      IF(NZ-1)290,290,295
  290 VALIN(L,I)=TDVAL *(1.0+1.0/(DISCO-1.0))
      RETURN
  295 DFVAL=FVAL(N)/DISCO
      VALIN(L,I)=TDVAL+DFVAL
      RETURN
      END
@XQT
```

APPENDIX B

Test Data for Computer Program

```
010106303030454545303030454545020101010101010102020202020202020201010102 02
02                02090201
LOBLOLLY PINE SITE INDEX 70 30 AND 45 YEAR ROTATIONS
PULPWOOD - CORDS    SAWTIMBER - MBF
00  30.  00  60.  00  90.  00  30.  00  60.  00  90.
20 6.  1.   20  6. 1.   20  6. 1.   20 6.  1.   20  6. 1.   20  6. 1.
30  7. 1.   30  7. 1.   30  7. 1.   30  7. 1.   30  7. 1.   30  7. 1.
30 5.3 1.   30 5.3 1.   30 5.3 1.   30 1.1 .9   30 1.1 .9   30 1.1 .9
                                    4511.7 1.   4511.7 1.   4511.7 1.
.60      .02      1.00     .02
    5.    .02      50.      .02
    5.    .02      75.      .02
    5.    .02      100.      .02
    8.    .02      50.      .02
    8.    .02      75.      .02
    8.    .02      100.      .02
    11.    .02      50.      .02
    11.    .02      75.      .02
    11.    .02      100.      .02
0.0
98
020106303030454545303030454545020202020202020202020202020202020101010202 02
02                02090201
LOBLOLLY PINE SITE INDEX 70 30 AND 45 YEAR ROTATION - RELEASE AGE 3
PULPWOOD - CORDS    SAWTIMBER - MBF
00  30.  00  60.  00  90.  00  30.  00  60.  00  90.
03  15.  03  15.  03  15.  03  15.  03  15.  03  15.
20 6.  1.   20  6. 1.   20  6. 1.   20 6.  1.   20  6. 1.   20  6. 1.
30  7. 1.   30  7. 1.   30  7. 1.   30  7. 1.   30  7. 1.   30  7. 1.
30 5.3 1.   30 5.3 1.   30 5.3 1.   30 1.1 .9   30 1.1 .9   30 1.1 .9
                                    4511.7 1.   4511.7 1.   4511.7 1.
.60      .02      1.00     .02
    5.    .02      50.      .02
    5.    .02      75.      .02
    5.    .02      100.      .02
    8.    .02      50.      .02
    8.    .02      75.      .02
    8.    .02      100.      .02
    11.    .02      50.      .02
    11.    .02      75.      .02
    11.    .02      100.      .02
0.0
99
```